suggest a photomask and method thereof having reflection preventing sections or films as claimed in claims 1 and 16.

Claim 2 claims a photomask and claim 17 claims a photomask fabrication method in which a shade pattern is formed on a surface on a surface of a transparent substrate and a phase shift pattern, which is planarized, is selectively formed on the shade pattern and the transparent substrate.

Through the structure and method of the claimed invention forming a shade pattern on the surface of a transparent substrate and selectively forming a phase shift pattern thereon having a planarized surface, as claimed in claims 2 and 17, the claimed invention provides a photomask and fabrication method thereof in which a phase shift pattern has a uniform thickness so that the contrast of an optical image is increased. The prior art does not show, teach or suggest a shade pattern formed on a surface of a transparent substrate and a phase shift pattern, which is planarized, selectively formed thereon as claimed in claims 2 and 17.

Claim 5 claims a photomask and claim 20 claims a photomask fabrication method in which a shade pattern is formed in a hollow section of a transparent substrate and a phase shift pattern, which is planarized, is selectively formed on the transparent substrate.

Thus, the claimed invention provides a photomask and a fabrication method thereof in which it is possible to increase the contrast of an optical image when semiconductor integrated circuits are fabricated using the phase shift photomask. The prior art does not show, teach or suggest a phase shift pattern, which is planarized, formed on the transparent substrate as claimed in claims 5 and 20.

Claim 7 claims a photomask and claim 22 claims a photomask fabrication method in which a transparent substrate is selectively etched, after forming the shade pattern, to form a phase shift pattern.

Thus, the claimed invention provides a photomask and fabrication method thereof in which it is possible to increase the contrast of an optical image when the photomask is used. The prior art does not show, teach or suggest forming a phase shift pattern from the substrate itself after the shade pattern is formed in the substrate as claimed in claims 7 and 22.

Claim 28 claims a photomask comprising a transparent substrate, a hollow section and a shade pattern including a shade section formed in the hollow section. The surface of the transparent substrate and the shade pattern are planarized to form a same surface.

Through the structure of the claimed invention planarizing both the transparent substrate and shade pattern to form a same surface, as claimed in claim 28, the present invention provides a photomask in which there is no mechanical stress that occurs during the washing process which increases the yield. The prior art does not show, teach or suggest planarizing both the transparent substrate and shade pattern to form a same surface as claimed in claim 28.

Claims 1, 2, 5, 7, 9-11, 14, 20, 22 and 28 were rejected under 35 U.S.C. § 102(b) as being anticipated by Hur et al. (U.S. Patent No. 5,437,927).

In addition, claims 17-19, 21 and 23 were rejected under 35 U.S.C. § 103 as being unpatentable over Hur et al.

Applicant respectfully traverses the Examiner's rejection of the claims under 35 U.S.C. § 102(b) and under 35 U.S.C. § 103. The claims have been reviewed in light of the Office Action, and for reasons which will be set forth below, it is respectfully requested that the Examiner withdraws the rejection to the claims and allows the claims to issue.

Hur et al. appears to disclose coating a transparent substrate 21 with a layer of photoresist material 22 and then forming a photoresist pattern. With the pattern photoresist layer 22 as a mask, the revealed substrate 21 is etched to form a trench 23. Upon removal of the photoresist layer 22, a layer of chrome 24 is deposited over the substrate 21. The layer of chrome 24 is etched back and then an opaque layer remains in the trench 23. A layer of oxide 26 with a layer of photoresist material 27 thereon is formed. The photoresist layer 27 is patterned and the oxide layer 26 is exposed at the portion corresponding to the partially removed photoresist layer. With the pattern photoresist layer 27 as a mask, the exposed oxide layer 26 is etched away to form a phase shift mask 28 over the substrate 21 which remains unetched between the trenches and then the photoresist layer is removed. (Col 3, lines 20-51). In Figures 5A to 5H, after the phase shifting layer 28 is formed, the quartz substrate 21 underneath the phase shifting layer 28 is etched. The phase shifting layer 28 and opaque layer 25 serve as the dry etch mask to form a groove on both sides of the trench 23. The quartz substrate 21 is etched to the optimize thickness for maximizing the light sensitivity. (Col 4, lines 32-47). FIG. 9A and 9F are the process steps of the mask in which the transparent quartz substrate 21 is coated the photoresist film 22 to form the photoresist pattern of width W through the well-known photolithographic

process (FIG. 9A). The patterned photoresist film 22 acts as the mask to form a trench 23 by etching the substrate 21 (FIG. 9B). Upon removal of the photoresist pattern 22, a layer of chrome 24 is deposited over the substrate 21 to fully fill the trench 23 (FIG. 9C). The physical and chemical polishing step makes the opaque layer 25 as high as the quartz substrate, thereby maintaining the smoothed level throughout the whole surface for planarization (FIG. 9D). Over the entire surface it is formed an oxide layer 26 on which a photoresist film is coated again. The coated photoresist film 27 is patterned to form a photoresist pattern by photolithography (FIG. 9E). Upon removal of the photoresist layer 27 after the formation of the phase shifting layer, it is obtained the edge enhancement phase shifting mask of the full filled trench with the opaque layer. (Col 5, lines 2-24).

Thus, Hur et al. merely discloses in FIG. 9F a phase shift pattern 28 formed from an oxide layer 26. Nothing in Hur et al. shows, teaches or suggests that the phase shift pattern 28 is a reflection preventing section as claimed in claims 1 and 16. Furthermore, nothing in Hur et al. shows, teaches or suggests that the reflection preventing sections are each formed according to one of a) on the shade section, b) under the shade section and c) on and under the shade section as claimed in claims 1 and 16. Rather, Hur et al. merely discloses an oxide layer 26 which is subsequently shaped into a phase shift pattern 28.

Applicant respectfully traverses the Examiner's statement that it is inherent that the phase shifting layer 28 is planarized since the layer is flat. Hur et al. merely draws schematically a phase shift film. Hur et al. does not show, teach or suggest the importance of a planarized film. In particular, planarization will eliminate thickness variations in the phase shift film which directly result in phase errors. Nothing in Hur et al. shows, teaches

or suggests the problems associated with thickness variations in the phase shift film and thus a solution to such a problem is not addressed nor suggested in Hur et al. Applicant respectfully points out that planarization involves specific processes to form a planar surface. No such planarization process is shown, taught or suggested by Hur et al. Thus, Hur et al. does not show, teach or suggest a phase shift pattern having a planarized surface as claimed in claims 2, 5, 17 and 20. Rather Hur et al. merely discloses a phase shifting layer 28 which is schematically drawn as flat but is not a planarized surface.

Furthermore, Applicant respectfully traverses the Examiner's statement that etching the substrate to form a trench, depositing an opaque material into the trench and forming another top layer on the opaque layer creates a specific phase shift pattern and thus teaches the etching of the substrate forms the phase shift pattern. Applicant respectfully points out to the Examiner that Hur et al. does not show, teach or suggest performing a chemical and mechanical polishing of the shade film, forming a resist film on the transparent substrate in which the shade pattern has been formed, selectively etching the resist film and selectively etching the transparent substrate as claimed in claim 22. In other words, nothing in Hur et al. shows, teaches or suggests forming a phase shift pattern by etching the transparent substrate subsequent to forming the shade pattern as claimed in claims 7 and 22. Thus nothing in Hur et al. shows, teaches or suggests etching the substrate to form a phase shift pattern after a shade pattern has been formed in the transparent substrate as claimed in claims 7 and 22. Furthermore, Applicant respectfully traverses the Examiner's statement on page 3, lines 7-9 of the Office Action. In particular, col. 4, lines 30-50 of

Hur et al. do not show, teach or suggest "chemical and mechanical polishing is performed..."

Finally, Hur et al. does not show, teach or suggest planarizing the transparent substrate and shade pattern to form a same surface as claimed in claim 28. At best, Hur et al. merely discloses planarizing a light-shielding layer 25 of a phase shift mask.

Since nothing in Hur et al. shows, teaches or suggests a) reflection preventing sections or films as claimed in claims 1 and 16, b) a phase shift pattern, which is planarized, as claimed in claims 2, 5, 17 and 20, d) a phase shift pattern formed by etching the transparent substrate subsequent to forming the shade pattern as claimed in claim 7, e) selectively etching a transparent substrate subsequent to forming the shade pattern as claimed in claim 22 or f) planarizing the substrate and shade pattern to form a same surface as claimed in claim 28, it is respectfully requested that the Examiner withdraws the rejection to claims 1, 2, 5, 7, 20, 22 and 28 under 35 U.S.C. § 102(b) and withdraws the rejection to claim 17 under 35 U.S.C. § 103.

Claims 9-11, 14, 18-19, 21 and 23 depend from claims 2, 17, 20 and 22 and recite additional features. It is respectfully submitted that the rejection of these claims would not have been anticipated or obvious within the meaning of 35 U.S.C. § 102(b) or under 35 U.S.C. § 103 at least for the reasons as set forth above. Therefore, it is respectfully requested that the Examiner withdraws the rejection to claims 9-11, 14, under 35 U.S.C. § 102(b) and withdraws the rejection to claims 18, 19, 21 and 23 under 35 U.S.C. § 103.

Claims 1, 2, 5, 7, 9-11, 14 and 28 were rejected under 35 U.S.C. § 102(e) as being anticipated by Lee (U.S. Patent No. 5,824,439).

Applicant respectfully traverses the Examiner's rejections of claims under 35 U.S.C. § 102(e). The claims have been reviewed in light of the Office Action and for reasons which are set forth below, it is respectfully requested that the Examiner withdraws the rejection to the claims and allows the claims to issue.

Lee '439 appears to disclose referring to FIG. 1D, the light-shading layer 13 is etched using an etchant so that the light-shading layer 13 is etched in a sideward direction. As a result, the lower part of the phase shifting layer 17 is undercut. Here, the undercut part of the phase shifting layer becomes a phase shifting region and the part which is in contact with the light-shading layer 13 becomes a light-shading region. A part where the phase shifting layer 17 is not formed is a light-transmission region. (Col 2, lines 1-8) FIG. 3 is a cross-sectional view of a phase shifting mask. As shown in FIG. 3, a groove 37 is formed on a predetermined region of a transparent substrate 31 made of a transparent material, e.g., soda lime glass or quartz. A light-shading layer 39 is formed within the groove 37. The phase shifting layer 41 is formed so as to be in contact with the transparent substrate 31 at both sides of the groove 37, thereby limiting the light-shading layer 39 to be within the groove 37. (Col 4, lines 11-17, Col 5, lines 43-47). Referring to FIG. 4D, the sacrificial layer 33 is selectively removed using an etchant, e.g., H_3PO_4, which has a high etch selectivity to the phase shifting layer 41, thereby exposing the transparent substrate 31. The exposed portion of the transparent substrate 31 becomes a light-transmission region. (Col 5, lines 50-55).

Thus, Lee '439 merely discloses a light shading layer 39 formed in a groove and a phase shift layer 41 in FIG. 3. Applicant respectfully traverses the Examiner's statement

that the phase shifting layers are inherently reflection preventing. Nothing in Lee '439 shows, teaches or suggests that these layers are reflection preventing. Column 2, lines 1-7 of Lee ' 439 merely discloses that the phase shifting layer 17 which is in contact with the light shading layer 13 becomes a light-shading region while the undercut part becomes a phase shifting region. Lee '439 does not show, teach or suggest that the phase shifting layer 17 is a reflection preventing section as claimed in claim 1.

Additionally, Applicant respectfully traverses the Examiner's statement that it is inherent that the phase shifting layer is planarized as it is flat. As pointed out above with regard to Hur et al., nothing in Lee '439 shows, teaches or suggests planarizing a phase shift pattern. Applicant respectfully points the Examiner to column 5, lines 35-37 which teaches polishing the deposited Zn or polycrystalline silicon to expose the sacrificial layer 33 and planarize. Thereafter oxygen ions are implanted into the Zn or polycrystalline silicon and heat treated to form the phase shifting layer 41. However, the planarization is done to the Zn or polycrystalline silicon prior to forming the phase shifting layer 41. The phase shifting layer 41 is not planarized after formation. Thus nothing in Lee '439 shows, teaches or suggests planarizing the surface of a phase shift pattern as claimed in claims 2 and 5. Furthermore, nothing in Lee ' 439 shows, teaches or suggests that the transparent substrate and shade pattern are planarized to form a same surface as claimed in claim 28.

Finally, nothing in Lee '439 shows, teaches or suggests that a phase shift pattern is formed by etching the transparent substrate subsequent to forming the shade pattern as claimed in claim 7.

Since nothing in Lee '439 shows, teaches or suggests a) reflection preventing sections as claimed in claim 1, b) a phase shift pattern, which is planarized, as claimed in claims 2 and 5, c) a phase shift pattern formed by etching a transparent substrate subsequent to forming the shade pattern as claimed in claim 7, or d) planarizing the shade pattern and substrate to form a same surface as claimed in claim 28, it is respectfully requested that the Examiner withdraws the rejection to claims 1, 2, 5, 7 and 28 under 35 U.S.C. § 102(e).

Claims 9-11 and 14 depend from claim 2 and recite additional features. It is respectfully submitted that claims 9-11 and 14 would not have been anticipated within the meaning of 35 U.S.C. § 102(e) by Lee '439 at least for the reasons as set forth above. Therefore, it is respectfully requested that the Examiner withdraws the rejection to claims 9-11 and 14 under 35 U.S.C. § 102(e).

Claims 4, 15 and 27 were rejected under 35 U.S.C. § 103 as being unpatentable over Hur et al. or Lee '439 in view of Lee et al. (U.S. Patent No. 6,017,659).

As discussed above, nothing in Hur et al. or Lee '439 show, teach or suggest a phase shift pattern, which is planarized, as claimed in claim 2, the slope of a shifter edge section as claimed in claim 4 or a phase shift pattern having a shifter in multiple steps as claimed in claim 27.

Lee et al. appears to disclose a phase transition portion 73 having additive steps 5000, 500', 50" which is gradually formed along the border between the phase shifting region 75 and the transparent substrate 71, thereby gradualizing the phase shift and preventing the light intensity from being degraded at the phase shift border.

Thus, Lee et al. merely discloses a phase transition portion having steps formed along the border between a phase shifting region and a transparent substrate by repeated lithography. Nothing in Lee et al. shows, teaches or suggests a phase shift pattern, which is planarized, as claimed in claim 2, polishing the slope of a shifter edge section using chemical and mechanical polishing as claimed in claim 4 or a phase shift pattern having an intermediate phase formed by a shifter in multiple steps as claimed in claim 27.

Claim 4 depends from claim 2 and recites an additional feature of a difference of a step between the phase shift pattern and transparent substrate gradually decreases.

Claim 15 depends from claim 2 and recites an additional feature that the phase shift pattern includes a phase shift pattern having a shade pattern formed with a phase shifter and the shade pattern is applied to a large area section.

Claim 27 depends from claim 2 and recites an additional feature that the phase shift pattern includes a phase shift pattern having an intermediate phase formed by a shifter in multiple steps.

It is respectfully submitted that claims 4, 15 and 27 would not have been obvious within the meaning of 35 U.S.C. § 103 over Hur et al. or Lee '439 and Lee et al. at least for the reasons as set forth above. Therefore, it is respectfully requested that the Examiner withdraws the rejection to claims 4, 15 and 27 under 35 U.S.C. § 103.

Claims 3, 6 and 8 were rejected under 35 U.S.C. § 103 as being unpatentable over Hur et al. or Lee '439 in view of Lee (U.S. Patent No. 5,972,540).

As discussed above, nothing in Hur et al. or Lee '439 shows, teaches or suggests a) a phase shift pattern, which is planarize, as claimed in claim 2 and claim 5 or b) a phase

shift pattern formed by etching the transparent substrate as claimed in claim 7. Furthermore, nothing in the references shows, teaches or suggests the slope of the edge section as claimed in claims 3, 6 and 8.

Lee '540 appears to disclose at column 5 lines 20-25 rectangular phase shifters 13A are heated and melted into hemispherical or rounded phase shifters 21 and thus phase shifters 22 are formed having planar top surfaces and round sidewalls.

Thus Lee '540 merely discloses phase shifters having round sidewalls formed by a reflow process from thermal heat treatment. Nothing in Lee '540 shows, teaches or suggests using chemical and mechanical polishing to form a slope at one edge section as claimed in claims 3, 6 and 8.

Claim 3 depends from claim 2 and recites an additional feature that the end section that is contacted to the transparent substrate has a sloped shape formed by chemical and mechanical polishing.

Claim 6 depends from claim 5 and recites an additional feature that the thickness of the end section gradually decreases due to chemical and mechanical polishing.

Claim 8 depends from claim 7 and recites an additional feature that the end section has a sloped shape formed by chemical and mechanical polishing.

It is respectfully submitted that claims 3, 6 and 8 would not have been obvious within the meaning of 35 U.S.C. § 103 over the references at least for the reasons as set forth above. Therefore, it is respectfully requested that the Examiner withdraws the rejection to claims 3, 6 and 8 under 35 U.S.C. § 103.

Claims 12 and 13 were rejected under 35 U.S.C. § 103 as being unpatentable over Hur et al. or Lee '439 in view of Tanabe (U.S. Patent No. 5,945,237).

As discussed above, nothing in Hur et al. or Lee '439 shows, teaches or suggests a phase shift pattern, which is planarized, selectively formed on the shade pattern and transparent substrate as claimed in claim 2.

Tanabe appears to disclose in a halftone phase-shift mask, a phase-inverting light transmission part is formed inside the light-blocking part which blocks light that is radiated onto a transparent substrate so as to cover a shifter missing part defect, this phase-inverting light transmission part inverting the phase of light that passes through it with respect to light that passes through a light transmission part.

Thus, Tanabe merely discloses a half tone phase shift mask and does not relate to chemical and mechanical polishing. Nothing Tanabe shows, teaches or suggests a phase shift pattern, which is planarized, selectively formed on the shade pattern and transparent substrate as claimed in claim 2.

Claim 12 depends from claim 2 and recites an additional feature that the phase shift pattern includes a half tone phase shift pattern.

Claim 13 depends from claim 2 and recites an additional feature that the phase shift pattern includes a half tone phase shift pattern with a shade pattern.

It is respectfully submitted that claims 12 and 13 would not have been obvious within the meaning of 35 U.S.C. § 103 over the references at least for the reasons as set forth above. Therefore, it is respectfully requested that the Examiner withdraws the rejection to claims 12 and 13 under 35 U.S.C. § 103.

Claims 16 and 24 were rejected under 35 U.S.C. § 103 as being unpatentable over Hur et al. in view of Mitsui (U.S. Patent No. 6,037,083).

As discussed above, nothing in Hur et al. shows, teaches or suggests a shade film and first and second reflection preventing films as claimed in claim 16.

Mitsui appears to disclose acid-resistant, highly reliable phase shift masks, and phase shift mask blanks, wherewith high-precision patterning is possible. A halftone phase shift mask blank comprising a transparent substrate 10, a halftone material film 11 laminated on that transparent substrate, and a metal film 12 laminated on that halftone material film, wherein the metal film is formed by a plurality of metal films having different etching rates, and the etching rate for the metal film positioned on the transparent substrate side is set so that it is faster, either in stages or continuously, than the etching rate of the metal film positioned on the surface side.

Thus, Mitsui merely discloses a metal film 12 laminated on a half tone material film where the metal film is formed by a plurality of metal films having different etching rates. Nothing in Mitsui shows, teaches or suggests forming a first reflection preventing film in each hollow section, forming a shade film on the first reflective preventing film, chemically and mechanically polishing this shade film to form a shade pattern and forming a second reflective preventing film on this shade pattern as claimed in claim 16. Rather, Mitsui merely discloses a metal film of a plurality of layers laminated on a half tone material film and is not related to chemical and mechanical polishing.

The combination of Hur et al. and Mitsui would not be possible since nothing in Hur et al. shows, teaches or suggests forming a first reflective preventing film in a hollow

section, forming a shade film on the first reflection preventing film, forming a shade pattern by chemical and mechanical polishing and forming a second reflection preventing film on the shade pattern as claimed in claim 16. Furthermore, nothing in Mitsui shows, teaches or suggests these features.

Applicant also respectfully points out that a metal light-shading film such as Cr is polished differently with an oxide film such as SOG and thus a CMP process for metal films is quite different from oxide films. Furthermore, Applicant respectfully points out that a phase shifter controls phase while a light-shading film controls amplitude, which is independent of phase. Therefore, there is no analogy for phase control verse amplitude control as suggested by the Examiner. Therefore, the combination of Hur et al. and Mitsui would not show, teach or suggest the invention as claimed in claim 16. It is therefore respectfully requested that the Examiner withdraws the rejection to claim 16 under 35 U.S.C. § 103.

Claim 24 depends from claim 16 and recites an additional feature that the radiation ray is one of an electron beaming from a laser beam and a monochromatic beam.

It is respectfully submitted that claim 24 would not have been obvious within the meaning of 35 U.S.C. § 103 over the references at least for the reasons as set forth above. Therefore, it is respectfully requested that the Examiner withdraws the rejection to claim 24 under 35 U.S.C. § 103.

Thus it now appears that the application is in condition for reconsideration and allowance. Reconsideration and allowance at an early date are respectfully requested.

Should the Examiner find that the application is not now in condition for allowance, it is respectfully requested that the Examiner enters this amendment for purposes of appeal.

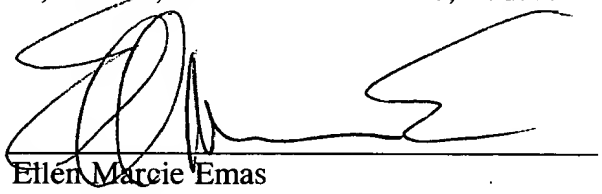
If for any reason the Examiner feels that the application is not now in condition for allowance, it is respectfully requested that the Examiner contact, by telephone, the Applicant's undersigned attorney at the indicated telephone number to arrange for an interview to expedite the disposition of this case.

In the event that this paper is not timely filed within the currently set shortened statutory period, Applicant respectfully petitions for an appropriate extension of time. The fees for such extension of time may be charged to our Deposit Account No. 02-4800.

In the event that any additional fees are due with this paper, please charge our Deposit Account No. 02-4800.

Respectfully submitted,

BURNS, DOANE, SWECKER & MATHIS, L.L.P.

By: 

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Date: March 2, 2001

Attachment to Amendment: Marked-up Claims 7 and 28

7. (Twice Amended) A photomask comprising:

a transparent substrate;

a hollow section formed on a surface of said transparent substrate;

a shade pattern made up of a shade film, said shade film formed in said hollow section; and

a phase shift pattern formed by etching said transparent substrate including said shade pattern formed in said hollow section.

28. (Amended) A photomask comprising:

a transparent substrate;

a hollow section formed on a surface of said transparent substrate; and

a shade pattern including a shade section, said shade section made up of a shade film and formed in said hollow section, wherein a surface of said transparent substrate and said shade pattern are planarized to form a same surface.